CARISSA CARANDAS AND ITS PHARMACOLOGICAL ASPECTS: A REVIEW

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Abstract-

The Apocynaceae family, which includes 1000 species and 300 taxa, includes Carissa carandas, also referred to as Karonda. The roots have salicylic acid and cardiac glycosides, which lower blood pressure a little. Additional volatile substances found in roots include lupeol, β-hydroxybetulinic acid, β-sitosterol, β-sitosterol glycoside, α-amyrin, carinol, lignan, sesquiterpenes, 2-acetyl phenol, and the acridone alkaloid des-N-methylnoracronycine. Analgesic, antipyretic, and anti-inflammatory properties of Carissa carandas root extracts in aqueous and ethanolic forms were investigated in mouse models. The antibacterial and in vivo wound healing capabilities of Carissa spinarum methanolic extract were examined. This review also includes Anthelmintic activity, Anti-diabetic, Anti-ulcer, Hepatoprotective activity, constipation and diarrohea, Cardiovascular activity, Anti-malarial activity of Carissa carandas.

Key words- Carrisa carandas, Karonda, Analgesic, antipyretic, and anti-inflammatory, Anthelmintic activity, Anti-diabetic , Anti-ulcer, Hepatoprotective activity, constipation and diarrohea, Cardiovascular activity, Anti-malarial activity of Carissa carandas.

Introduction:

The Apocynaceae family, which includes 1000 species and 300 taxa, includes Carissa carandas, also referred to as Karonda. The genus Carissa has over thirty species that are indigenous to Asia, Africa, Australia, and China's tropical and subtropical regions. Indian pickles and spices employ its berry-sized fruits as a seasoning or additive Afghanistan, Nepal, India, Sri Lanka, Java, Malaysia, Myanmar, Australia, South Africa, and Pakistan are among the countries where the plant is found[1]. Native to the Indian subcontinent, Carissa carandas are found in Malacca, Sri Lanka, and Myanmar. It was later brought to Java, where it is currently widely used[2]. With branches, Carissa carandas L. is a big, spiny, evergreen tree that can reach a height of 4 meters. It has a white latex-rich stem and branches with sharp spines. The leaves are oblong and conical, measuring 4-6 inches in length and 2-3 inches in breadth. Clusters of three to ten berries are formed. Ripe fruits are purplish or green, but unripe fruits are pink. The thick, velvety bark is gray in hue[3]. Due to its biologically active components, which include flavonoids, alkaloids, phenolic components, saponins, cardiac glycosides, and triterpenoids, Carissa carandas L. has drawn increased interest as a medicinal source. The roots have salicylic acid and cardiac glycosides, which lower blood pressure a little. Additional volatile substances found in roots include lupeol, β-hydroxybetulinic acid, β-sitosterol, β-sitosterol glycoside, α-amyrin, carinol, lignan, sesquiterpenes, 2-acetyl phenol,

and the acridone alkaloid des-N-methylnoracronycine[4,6]. The stem contains a lot of sesquiterpene glucoside[7]. Tannins and triterpenes were detected in the leaves. Additionally, a novel substance called carrissic acid, an isomer of urosolic acid, has been discovered in leaves[8]. A variety of volatile chemicals, such as β-caryophyllene, carindone, linalool, lupeol, benzyl acetate, β-sitosterol, and ascorbic acid, are found in fruits[9]. Additionally found in Carissa carandas are hydrocarbons (50–60%), fixed oil (3-5%), free acid (25–30%), crude proteins (12–15%), and polyphenols (7–8%). The most used technique for determining an oil's chemical makeup is GCMS analysis.[10-14].

Taxonomic classification[15]

Scientific name- Carissa carandas

Kingdom-Plantae

Class-Angiosperm

Order-Gentianales

Family-Apocynaceae

Genus-Carissa

Species-C. carandas

Table 1: Different phytochemical constituents of Karonda plant and their probable therapeutic and medicinal roles

Root

S.no.	Various phytochemical components found in Karonda root	Potential medical and therapeutic functions
1.	Salicylic acid	renowned for its anti-inflammatory properties, which include lowering temperature and relieving aches and pains.[16]
2.	Carindone	Antibacterial activity[17]
3.	Lupeol	Dietary triterpene that has anti-inflammatory and anti-cancer properties[18]

4.	Carinol (a phenolic lignan)	Antioxidant, Antibacterial compound[19]
5.	Carissone	Antibacterial compound[17]

Fruit

S.no.	Various phytochemical components found in Karonda fruit	Potential medical and therapeutic functions
1.	Linalool	Antimicrobial effect[20]
2.	2-phenly ethanol	Antimicrobial effect[21]
3.	β-D-glucosides	Anti-microbial activity[22]
4.	Benzyl acetate	Anti-Infective agents, Local Anti-Inflammatory agents[23]
5.	Carissol	Anti-viral activity[24]

Leaf

S.no.	Various phytochemical components found in Karonda leaf	Potential medical and therapeutic functions
1.	Ursolic acid	Anti-obesitic activity, Anti-cancer activity Cardioprotective[25]
2.	Carissin	Anti-cancer and useful for treating Herpes simplex virus[26]
3.	Oleanolic acid	Anti-inflammatory And Anti-hyperlipidemic , Hepatoprotective[27]

Carissa carandas pharmacological potential and traditional medical applications

Carrisa carandas fruits have been widely employed in India's rural communities for centuries in traditional medical systems such as Ayurveda, Unani, and homeopathy[28]. Historically, karonda fruits have been used to treat a variety of ailments, including anorexia, indigestion, heart disease, oedema, hepatomegaly, splenomegaly, colic, and amenorrhea. In addition to these, they are used to treat intestinal worms, stomachaches, diarrhea, myopathic spasms, fever, cough, and colds, female libido, leprosy, and other skin conditions, as well as malaria, epilepsy, and discomfort[29]. The traditional medical system uses ripe fruits as an antiscorbutic and to cure nausea, whereas unripe fruits are used as an astringent[30]. It is effective against anemia because of its high iron

content. Karonda fruit is good against scurvy because of its high vitamin C concentration. They have hepatoprotective, antipyretic, cardioprotective, anti-inflammatory, antimicrobial, antifungal, analgesic, antiscorbutic, anti-anorexic, anthelmintic, astringent, and blood purifying qualities[31-35].

Analgesic, anti-inflammatory, and antipyretic activities:

Analgesic, antipyretic, and anti-inflammatory properties of Carissa carandas root extracts in aqueous and ethanolic forms were investigated in mouse models[36]. At dose levels of 0.1 and 0.2g/Kg, the extracts demonstrated significant ($p<0.01$) analgesic, anti-inflammatory, and antipyretic properties. At a dose of 0.1g/kg, the ethanol extract from Carissa carandas showed an approximate 72% suppression of abdominal constriction. Additionally, there was a notable decrease in carrageenan-induced edema in both ethanol and aqueous extracts of Carissa carandas. Methanol extracts from Carissa carandas leaves were investigated in a different investigation[37]. The highest inhibitory effect of the extract against edema caused by dextran, carrageenan, and histamine was observed at a dose level of 0.2g/kg. Using sick albino rats, the extracts' antipyretic activity was investigated. The extracts' strongest antipyretic activity was observed at concentrations of 0.1 and 0.2 g/kg. Rats' edema caused by carrageenan showed a notable reduction in inflammation when dried fruit methanol extracts were administered. Another study investigated the anti-inflammatory effects of a methanol extract of dried Carissa carandas fruits on mice with edema based on carrageenan. Upon oral administration, extracts demonstrated a significant ($p\leq0.05$) anti-inflammatory effect[38].

Wound healing Activity:

The antibacterial and in vivo wound healing capabilities of Carissa spinarum methanolic extract were examined. On a mouse burn wound model, the impact of a methanolic extract of Carissa spinarum root obtained by cold maceration was assessed. The rate of wound contraction, epithelization time, and hydroxyproline concentration were used to evaluate the wound healing activities of 1% and 2.5% (w/w) extract. A histological analysis of the granulation tissue was done to determine how much collagen had formed in the wound tissue. The extract's antibacterial activity was also investigated using the agar dilution method against strains of bacteria and fungi. The results showed the significant wound healing ability of Carissa spinarum root extract, as evidenced by the rate of wound contraction and epithelization. The discovered healing pattern also showed a strong correlation with histological parameters and hydroxyproline expressions. Significant antibacterial activity was also demonstrated by the methanolic extract against every tested pathogen. The traditional application of Carissa spinarum in wound care is supported scientifically by this investigation[39].

Anthelmintic activity:

Utilizing Indian earthworms (Pheretima posthuma), the in-vitro anthelmintic efficacy of petroleum ether (60–80), chloroform, and ethanolic unripe fruit extract of Carissa carandas Linn was assessed. The time of worm paralysis and death was used to examine the anthelmintic potency of

the varied solvent extract concentrations (50, 100, and 150 mg/ml) in vitro. As typical medications, piperazine citrate (15 mg/ml) is utilized. The current study's findings suggest that an extract from unripe Carissa carandas Linn. fruits has the ability to paralyze earthworms and eventually kill them. Higher doses of ethanolic extract (EECC), chloroform extract (CECC), and pet ether extract (PEECC) (150 mg/ml) resulted in the shortest paralysis times, measuring 56.35 minutes, 40 minutes, and 22.35 minutes, respectively. The existence of certain significant phytoconstituents in EECC allowed it to paralyze the earthworm faster than other unripe fruit extracts of Carissa carandas Linn. Therefore, current research shows that Carissa carandas Linn's unripe fruit extract has an anthelmintic effect on Pheretima posthuma.[40].

Antiulcer activity:

Due to the negative effects and drug interactions of allopathic medications, natural sources of antioxidant and antiulcer activity have also been found to have grown. This study's primary goal is to examine the antioxidant and antiulcer properties of a 60% ethanolic leaf extract of Carissa carandas Linn. A model of stomach ulcers caused by ethanolic acid was used to study antiulcer activity. Carissa Carandas Linn,. at doses of 100, 200, and 400 mg/kg, respectively, demonstrated protection indices of 42.45%, 47.17%, and 64.15%, whereas the conventional medication omeprazole likewise demonstrated a protection index of 73.59%, which was statistically more significant. To examine the antioxidant activity, the DPPH free radical scavenging experiment was used. Ascorbic acid and the extract had respective IC50 values of 3.56 µg/ml and 15.01 µg/ml.

To determine and separate the parts of Carissa carandas Linn. that are responsible for these kinds of actions, more research can be conducted.[41].

Anti-diabetic activity:

Gaurav et al.[42] tested the anti-diabetic effects of an aqueous extract of C. carandas leaves on Wister rats that were alloxan-induced and normoglycemic. They discovered that the drug's dosages of 500 and 1000 mg/kg significantly ($P<0.05$) lowered the blood glucose levels of the rats at 4, 8, and 24 hours. The plant extract exhibited strong anti-hyperglycemic and hypoglycemic effects ($P<0.05$) at both dosages. Additionally, Itankar et al.[43] tested the anti-diabetic effects of methanolic extract and its fruit fraction in rats with diabetes caused by alloxan. When compared to diabetic control, it has been observed that the methanol extract and its ethyl acetate soluble fraction have considerably reduced elevated blood glucose levels at a dose level of 400 mg/kg p.o. after 24 hours. Through fractionation, which increased polymerization and separated secondary metabolites flavonoids and phenolic compounds, the researchers were able to partially purify the ethyl acetate component, which gave it an antidiabetic advantage over methanol extract.

Hepatoprotective activity:

Hegde and Joshi[44] found that an ethanolic extract of C. carandas roots (ERCC; 100, 200, and 400 mg/kg, p.o.) exhibited considerable hepatoprotective efficacy against hepatotoxicity caused by CCl4 and paracetamol. The levels of uric acid, glutathione, superoxide dismutase, catalase, and

protein are significantly elevated, whereas the activities of bilirubin, lipid peroxidation, and serum marker enzymes are decreased. Aqueous extracts of C. carandas roots and ethanol were shown to have hepatoprotective properties against rats' ethanol-induced hepatotoxicity, according to Bhaskar and Balakrishnan[45]. By lowering blood transaminase, alkaline phosphate, bilirubin, and lipid peroxidation while markedly raising liver glutathione and serum protein levels, the ethanol and aqueous extracts at dose levels of 100 mg/kg and 200 mg/kg result in notable hepatoprotection.

Constipation and diarrhea:

Mehmood et al.[46] investigated the pharmacological utility of a crude extract of C. carandas leaves in the treatment of constipation and diarrhea in mice, isolated rabbit jejunum, and guineapig ileum preparations through in vitro tests.HPLC indicated that the extract included β-sitosterol, stigmasterol, ursolic acid, and oleanolic acid. Therefore, they came to the conclusion that the crude extract of C. carandas has a gutstimulatory action that is mostly mediated by the activation of histaminergic and muscarinic receptors, while its spasmolytic impact may be mediated by the Ca++ antagonist pathway.

Antimalarial activity:

Bapna et al.[47] examined the antimalarial properties of three distinct plant components (fruit, stem bark, and leaves) of the C. carandas plant against the Plasmodium falciparum 3D7 strain. Methanolic extract showed potential antimalarial activity (IC50 ranged between 13.57 and 69.63 µg/mL) among the two solvent extracts examined, in contrast to aqueous extracts (IC50 ranged between 41.52 and >100 µg/mL).

Cardiovascular activity:

In 2012, Shamim and Ahmad[48] assessed the impact of C. carandas extract on normal rats' cardiovascular function. When this extract was administered intravenously as a bolus at doses ranging from 5 to 45 mg/kg, arterial blood pressure decreased dose-dependently ($p<0.001$). The mean arterial blood pressure significantly decreased (50.75%) with the 45 mg/kg dose. Following CC injection at a dose of 45 mg/kg, a substantial decrease in heart rate frequency was noted ($p<0.001$). According to the researchers, the ethanol extract from C. carandas activates the muscarinic receptors on the vasculature's endothelial cells. As a result, nitric oxide or endothelial-derived relaxing substances are released, which diffuse to the smooth muscles of the vasculature and induce relaxation.

Anti-cancer and anti-oxidant activities:

The anti-cancerous properties of Carissa carandas leaves and their ripe and unripe fruit extract were assessed against lung cancer cells and ovarian carcinoma cells utilizing methanol, nhexane, and chloroform as solvent systems[49]. The extracts exhibited strong anti-cancer properties. The antioxidant and anticancer properties of aqueous leaf extracts from Carissa carandas were investigated in a different study using MCF-7 cancer cell lines. In the MCF-7 line, leaf extracts

showed a strong antioxidant effect and stopped cell death. Regular daily fruit consumption lowers the incidence of cancer and other infectious diseases, according to the study's findings[50].

Anticonvulsant activity:

Carissa carandas root extract (ethanol) was tested for its anti-convulsant properties in chemically and electrically based seizures at dose levels of 0.1, 0.2, and 0.4 g/kg. The extract dramatically shortened the length of time that mice experienced seizures brought on by electric shock at concentrations of 0.2 and 0.4 g/Kg. The model mice were shielded against tonic seizures brought on by pentylenetetrazole, N-methyl-dl-aspartic acid, and picrotoxin by the same dosages. The extract had no discernible impact on seizures based on bicuculline. Because the extract shortened the duration of electrically generated seizures and postponed the latency of picrotoxin and pentylenetetrazole-induced seizures, researchers came to the conclusion that C. carandas root extracts have anticonvulsant potential[51].

Antimicrobial activity:

Several bacterial species, including B. subtillis, E. coli, S. aureus, S. faecalis, P. aeruginosa, and S. typhimurium, are susceptible to the potent antibacterial activity of the ethanolic extract of Carissa carandas fruit [52]. Additionally, at concentrations of 3 µg/ml, 6 ug/methanol, and pylorus ligation, the ethanolic extract demonstrated antiviral activity against the polio Sindb virus and the herpes simplex virus. Acetic acid-induced chronic stomach ulcers healed more quickly after all extracts were used ($p<0.05$)[53].

Anti-depressant activity:

Examined the potential underlying processes in rats and the antidepressant-like effects of various root bark fractions in rodents. N-butanol, ethyl acetate, and water were used in that sequence to fractionate a 70% ethanol extract of the root bark. The fractions were administered at varying doses (50, 100, and 200 mg/kg), 2% Tween 80, or imipramine (30 mg/kg) to animals of both sexes. The tail suspension test and the forced swim test were used to measure the length of immobility. The open field test assessed locomotor activity. Alkaloids, flavonoids, total phenols, and serum corticosterone levels were measured. Additionally, preliminary mechanistic investigations were conducted to investigate potential active fraction modes of action.
The ethyl acetate fraction was the most active, and all fractions save the watery fraction considerably ($p<0.001$) reduced the length of immobility in both experiments. The activity was not caused by non-specific psychostimulant effects, according to the locomotor test. Mechanistic investigations revealed the participation of several neurotransmission systems, such as the Larginine-NO-cGMP pathway and the adrenergic, dopaminergic, and cholinergic systems. In comparison to the n-butanol fraction, the ethyl acetate had higher concentrations of phenols (42.42 vs. 29.8 mgGAE/g), flavonoids (12.43 vs. 2.07 mgQE/g), and alkaloids (0.17 vs. 0.07 mgATE/g). All of the assessed results point to the existence of medium-polar phenols, flavonoids, and alkaloids, which give the ethyl acetate and n-butanol fractions antidepressant-like properties[54].

Conclusion-

Karonda is a fruit that is only found in the wild and is underappreciated and ignored. Its richness in nutrients and phytochemicals opens the door for its application in functional and nutraceutical approaches in addition to pharmacology. The pharmacological potential of these underutilized and neglected fruits is extensive and includes antidiabetic, anti-inflammatory, anthelmintic, anticancer, antidiarrheal, antiemetic, nephroprotective, hepatoprotective, wound-healing, adaptogenic, and antiaging properties. They are capable of efficiently inhibiting a large variety of bacteria and a small number of viruses that cause human illnesses.

Reference:

1. Sawant, R. B., et al. "Genotypic and phenotypic variability in karonda (Carissa carandas L.)." (2002): 266-268.
2. Maheshwari, R., A. Sharma, and D. Verma. "Phyto-therapeutic significance of karaunda." *Bull Environ Pharmacol Life Sci* 1.12 (2012): 34-36.
3. Maheshwari, R., A. Sharma, and D. Verma. "Phyto-therapeutic significance of karaunda." *Bull Environ Pharmacol Life Sci* 1.12 (2012): 34-36.
4. Rastogi, RC, Et Al. "Studies on Carissa carandas Linn. Part I. Isolation of the cardiac active principles." (1966): 132-8.
5. Ganapaty, S., Ch Bharath, and H. Laatsch. "Des-N-Methylnoracronycine from the roots of Carissa conjesta. Wight." *International Journal of Green Pharmacy (IJGP)* 4.3 (2010).
6. Singh, A. K. A. N. S. H. A., and GURSIMRAN KAUR Uppal. "A review on carissa carandas ğ phytochemistry, ethnoğpharmacology, and micropropagation as conservation strategy." *Asian J Pharm Clin Res* 8.3 (2015): 26-30.
7. Wangteeraprasert, Ruchira, and Kittisak Likhitwitayawuid. "Lignans and a sesquiterpene glucoside from Carissa carandas stem." (2009): 1217-1223.
8. Siddiqui, Bina S., et al. "Triterpenoidal constituents of the leaves of Carissa carandas." *Natural product research* 17.3 (2003): 153-158.
9. Devmurari, V., et al. "A review: Carissa congesta: phytochemical constituents, traditional use and pharmacological properties." *Pharmacognosy Reviews* 3.6 (2009): 375.
10. JAMIL, MUHAMMAD SALMAN, et al. "Nutritive evaluation of medicinal plants being used as condiments in South Asian Region." *Journal of the Chemical Society of Pakistan* 30.6 (2011): 400.
11. Al-Maskri, Ahmed Yahya, et al. "Essential oil from Ocimum basilicum (Omani Basil): a desert crop." *Natural product communications* 6.10 (2011): 1934578X1100601020.
12. Arshad, Zartashia, et al. "Role of essential oils in plant diseases protection: a review." *International Journal of Chemical and Biochemical Sciences* 6 (2014): 11-17.
13. Hanif, Muhammad Asif, et al. "Essential oil composition, antimicrobial and antioxidant activities of unexplored Omani basil." *Journal of Medicinal Plants Research* 5.5 (2011): 751-757.
14. Hanif, Muhammad Asif, et al. "Analytical evaluation of three wild growing Omani medicinal plants." *Natural product communications* 6.10 (2011): 1934578X1100601010.
15. Bhosale, Saurabh Vilas, et al. "A Review on Carissa carandas: Traditional Use, Phytochemical Constituents, and Pharmacological properties." *Journal of Drug Delivery and Therapeutics* 10.6-s (2020): 145-150.
16. Kumar, D., V. Pandey, and V. Nath. "Karonda (Carissa congesta) an underutilized fruit crop." *Peter, KV, Underutilized and underexploited Horticultural Crops. New India publishing agency* 1 (2007): 313-325.

17. Lindsay, Elizabeth A., et al. "Antibacterial compounds from Carissa lanceolata R. Br." *Phytochemistry* 55.5 (2000): 403-406.
18. Saleem, Mohammad. "Lupeol, a novel anti-inflammatory and anti-cancer dietary triterpene." *Cancer letters* 285.2 (2009): 109-115.
19. Hettiarachchi, Dhanushka S., Cornelia Locher, and Robert B. Longmore. "Antibacterial compounds from the root of the indigenous Australian medicinal plant Carissa lanceolata R. Br." *Natural Product Research* 25.15 (2011): 1388-1395.
20. Park, Soon-Nang, et al. "Antimicrobial effect of linalool and α-terpineol against periodontopathic and cariogenic bacteria." *Anaerobe* 18.3 (2012): 369-372.
21. Panda, Debasish, et al. "Karonda (Carissa spp.): an underutilized minor fruit crop with therapeutic and medicinal use." *International Journal of Economic Plants* 1.1 (2014): 36-41.
22. Pullaiah, Thamminen. *Encyclopaedia of world medicinal plants*. Vol. 1. Daya books, 2006.
23. Anonymous, 2013b. http://www. phenomenex.com Compound?id=Benzyl+acetate
24. Tolo, F. M., et al. "The antiviral activity of compounds isolated from Kenyan Carissa edulis (Forssk.) Vahl." *JMPR* 4.15 (2010): 1517-22.
25. Liobikas, Julius, et al. "Uncoupling and antioxidant effects of ursolic acid in isolated rat heart mitochondria." *Journal of natural products* 74.7 (2011): 1640-1644.
26. Anonymous, 2013c. http://www.plantzafrica.com/plantcd/ carissaedulis.htm
27. Liu, Jie. "Pharmacology of oleanolic acid and ursolic acid." *Journal of ethnopharmacology* 49.2 (1995): 57-68.
28. Belwal, Tarun, Indra D. Bhatt, and Hari Prasad Devkota, eds. *Himalayan Fruits and Berries: Bioactive Compounds, Uses and Nutraceutical Potential*. Academic Press, 2022.
29. Tesfaye, T., and Y. D. Ravichadran. "Traditional Uses, Pharmacological Action and Phytochemical Analysis of Carissa carandas Linn." *A Review. Natural Products Chemistry & Research* 6.5 (2018): 1-20.
30. Bhosale, Saurabh Vilas, et al. "A Review on Carissa carandas: Traditional Use, Phytochemical Constituents, and Pharmacological properties." *Journal of Drug Delivery and Therapeutics* 10.6-s (2020): 145-150.
31. Singh, A. K. A. N. S. H. A., and GURSIMRAN KAUR Uppal. "A review on carissa carandas ğ phytochemistry, ethnoğpharmacology, and micropropagation as conservation strategy." *Asian J Pharm Clin Res* 8.3 (2015): 26-30.
32. Tuladhar, Astha. "Various uses of Karonda (Carissa carandas L.) in the Indian subcontinent." *Bulletin of the College of Liberal Arts and Sciences No* 5 (2020): 33-39.
33. Jayakumar, Kaliyamoorthy, and B. Muthuraman. "Traditional uses and nutrient status of Indian native plant fruit (Carissa carandas Linn.)." *World Scientific News* 96 (2018): 217-224.
34. Kumar, Sunil, Pallavi Gupta, and V. K. L. Virupaksha Gupta. "A critical review on Karamarda (Carissa carandas Linn.)." *International Journal of Pharmaceutical & Biological Archives* 4.4 (2013): 637.
35. Wani, R. A., et al. "Shelf life of Karonda jams (Carissa carandas L.) under ambient temperature." *African Journal of Agricultural Research* 8.21 (2013): 2447-2449.

36. Bhaskar, V. H., and N. Balakrishnan. "Analgesic, anti-inflammatory and antipyretic activities of Pergularia daemia and Carissa carandas." (2009): 168-174.
37. Hati, Manoranjan, et al. "Evaluation of anti-inflammatory and anti-pyretic activity of Carissa carandas L. leaf extract in rats." *J Pharm Chem Biol Sci* 1.1 (2014): 18-25.
38. Anupama, N., G. Madhumitha, and K. S. Rajesh. "Role of dried fruits of Carissa carandas as anti-inflammatory agents and the analysis of phytochemical constituents by GC-MS." *BioMed Research International* 2014.1 (2014): 512369.
39. Sanwal, Ritu, and Amrendra Kumar Chaudhary. "Wound healing and antimicrobial potential of Carissa spinarum Linn. in albino mice." *Journal of Ethnopharmacology* 135.3 (2011): 792-796.
40. Mishra, Chanchal Kumar, D. Sasmal, and B. Shrivastava. "An in vitro evaluation of the anthelmintic activity of unripe fruits extract of Carissa carandas Linn." *Int J Drug Dev Res* 4.4 (2012): 393-7.
41. Maurya, Ram Veer, and Atul Kumar. "A REVIEW ON–PHARMACOLOGICAL EFFECT OF CARISSA CARANDAS L." (2023).
42. Swami, G., et al. "Effect of aqueous leaves extract of Carissa carandas Linn on blood glucose levels of normoglycemic & alloxan induced diabetic Wister rats." *Int J Curr Pharm Res* 2.3 (2010): 65-67.
43. Itankar, Prakash R., et al. "Antidiabetic potential of unripe Carissa carandas Linn. fruit extract." *Journal of Ethnopharmacology* 135.2 (2011): 430-433.
44. Hegde, Karunakar, and Arun B. Joshi. "Hepatoprotective effect of Carissa carandas Linn root extract against CCl 4 and paracetamol induced hepatic oxidative stress." (2009).
45. Bhaskar, V. H., and N. Balakrishnan. "Hepatoprotective activity of laticiferous plant species (Pergularia daemia and Carissa carandas) from Western Ghats, Tamilnadu, India." (2009): 130-142.
46. Mehmood, Malik Hassan, et al. "Pharmacological basis for the medicinal use of Carissa carandas in constipation and diarrhea." *Journal of Ethnopharmacology* 153.2 (2014): 359-367.
47. Bapna, S., M. Ramaiya, and A. Chowdhary. "Antimalarial activity of Carissa carandas Linn. against Plasmodium falciparum." *J Antimicrob (Photon)* 12.8 (2013): 246-50.
48. Shamim, Sumbul, and Syed Iqbal Ahmad. "Pharmacodynamic study on acute hypotensive activities of Carissa carandas extract in normal rats." *Pak. J. Pharm. Sci* 25.3 (2012): 577-582.
49. Sulaiman, Shaida Fariza, et al. "Anticancer study of Carissa carandas extracts." *Project Report. USM* (2008): 1-6.
50. David, Muniswamy, and Gururaja Karekalammanavar. "SPECTROGRAPHIC ANALYSIS AND IN VITRO STUDY OF ANTIBACTERIAL, ANTICANCER ACTIVITY OF AQUEOUS ETHANOLIC FRUIT EXTRACT OF CARISSA CARANDAS L." *Journal of Advanced Scientific Research* 6.03 (2015): 10-13.
51. Hegde, Karunakar, et al. "Anticonvulsant activity of Carissa carandas Linn. root extract in experimental mice." *Tropical Journal of Pharmaceutical Research* 8.2 (2009).

52. Jigna, P., N. Rathish, and C. Sumitra. "Preliminary screening of some folklore medicinal plants from western India for potential antimicrobial activity." *Indian journal of pharmacology* 37.6 (2005): 408-409.
53. Merai, Ankit H., and Anil G. Jadhav. "Anti ulcer activity of Carissa carandas using root extract in albino rats." (2014): 1314-1326.
54. Ali, Hana Saif, and Ephrem Engidawork. "Antidepressant-Like Activity of Solvent Fractions of the Root Bark of Carissa spinarum Linn.(Apocynaceae) in Rodents Involves Multiple Signaling Pathways." *Journal of Experimental Pharmacology* (2022): 379-394.